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Is the information sufficient to create a new market for digestate?

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Abstract. Unfamiliarity with a good reduce the chances to be used by consumers. This is the case of digestate which is an organic soil conditioner obtained as by-product of biogas chain. The use of digestate as alternative to traditional manure is still not very widespread due to the lack of knowledge among farmers. In our survey, we explored whether providing farmers with information about the digestate can affect farmers' willingness to pay for buying it instead of the traditional manure used by farmers as soil conditioner. By conducting a hypothetical multiple-price list experiment we show that information positively affects farmers' willingness to pay (WTP) for digestate but information alone is not sufficient to create a new market for it because at the same price farmers always continue to buy manure. This finding raises some questions when estimating the effect of information, which while positive does not shift farmers' decisions to use an unfamiliar good. This result suggests that information provided to farmers elicited a WTP not sufficient to replace traditional manure with digestate.

Keywords: Unfamiliar goods, Information, Willingness to Pay.
JEL codes: D80, Q19.

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1. INTRODUCTION

In recent years, studies on energy supply have highlighted the importance of innovation applied to the production of energy from renewable energy sources. Currently, a strategic role is assumed by the use of agro-industrial by-products for the production of biomethane by anaerobic digestion and of the by-product that is generated by this process, that is the digestate. Actually, the process of the anaerobic digestion for the production of biogas is the most integrated at the farm level. In this rural context, great importance assumes the production and the use of the digestate as organic soil improvers (Dahlin et al., 2015).

The digestate contains organic and inorganic matters that could be risky contaminants to the environment if not properly treated, but at the same time

digestate is a potential renewable resource if adequately recovered (Herbes et al., 2020a; Wang and Lee, 2021).

In recent years, the amount of digestate produced worldwide has increased due to the increased number of anaerobic digestion plants and their production capacity. In fact, the new digesters for the production of biomethane have sizes upper than 1,000 kWh_{el}, to justify the costs for the upgrading system of the biogas (Selvaggi et al., 2021). This will lead to an increase in the amount of produced digestate raising the question of how to properly value the digestate (Monlau et al., 2015).

In the context of circular economy, the digestate could play an important role as it is able to close a virtuous cycle of production improving the sustainability of the entire agricultural production process (Mauceri et al., 2017; Tambone et al., 2009). In fact, digestate is a stabilized soil conditioner with excellent fertilizing characteristics due to the content of organic matter, micro and macro-elements of plant nutrition (Sogn et al., 2018). Although the anaerobic digestion process leads to several changes in the composition of the resulting digestate compared to the original feedstock, the digestate contributes to maintaining and improving soil quality (Hati et al., 2006; Möller and Müller, 2012).

Recently, the importance of the digestate as soil conditioner has been further enhanced because the input biomasses for the digester are principally by-products and not dedicated crops. Digestate thus represents a useful tool to return to the soil the nutrients consumed to produce agricultural products (oranges, olives, wheat and others). In this context, the digestate represents a low-cost source of natural fertilizer for the farmers able to increase soil yields and hydrologic stability. At the same time, using digestate decreases erosion process and the rate of soil salinity (Alburquerque et al., 2012). Finally, from an economic point of view, the digestate is an opportunity for the farmers both in terms of reducing costs and farmers' dependence on industrial fertilisers (Cerruto et al, 2016; Manetto et al., 2020; Selvaggi et al., 2018a).

Despite several benefits, the use if the digestate is still limited and many farmers have not even heard about it especially in those geographical areas where anaerobic digestion plants are still not widespread (Manetto et al., 2016). Moreover, Pappalardo et al (2019) noted that the willingness to pay (WTP) for the digestate depends on how much information is available among farmers. Although past studies have shown that farmers and/or consumers are willing to entry the digestate market (Dahlin et al., 2015; Herbes et al., 2020b), and purchase it (Selvaggi et al., 2021), understanding what drivers play a relevant role in the digestate purchasing process remains an open question, especially regarding the motivations that may influence its purchase instead of other soil conditioners like manure traditionally used and already well-known among consumers.

However, the effect of information on consumers' WTP for "unfamiliar" goods is still an opened question among scholars. In the case of the digestate, the established use of other soil conditioners like the cow manure and the "unfamiliarity" with new products like the digestate could make the choice of farmers to buy the digestate even more difficult.

"Unfamiliarity" with digestate makes it difficult to evaluate how much farmers are willing to pay for buying it and consequently find appropriate methods to capture the economic value of the digestate. Actually, "unfamiliarity" is a common problem when evaluating novel or new products mainly due to the "commitment costs" phenomenon (Bazzani et al., 2017; Zhao and Kling, 2001; 2004). In general, people overstate their preferences for familiar goods and understate their preferences for a relatively unfamiliar good (Cerroni, 2020). This gap is more accentuated between laboratory experiments and naturally occurring markets (Lusk and Norwood, 2009). According with the theory of commitment costs and with reference to the digestate, farmers' WTP also depends on how much time the farmer has to decide whether or not to buy the digestate (Pappalardo et al., 2018).

In order to reduce consumer's "unfamiliarity" with a good, an interesting approach is to refer not only to the effect of information on WTP but also to compare the "unfamiliar" good about which detailed information is provided with a similar substitutable good that is already known among consumers (Gilmour et al., 2019). Making comparisons between "unfamiliar" and "familiar" goods along with providing consumers with information on the "unfamiliar good" can reveal useful insights into whether consumers will actually buy the new and "unfamiliar" good instead of another good that is already well known among consumers (Ortega et al., 2020).

This is an under-explored approach in the scientific literature as most studies mainly focused on assessing willingness to pay and factors that influence it or alternatively which of two similar, substitute goods are chosen by the consumer. Rarely, it is evaluated whether the WTP placed by consumers on "unfamiliar" goods under the effect of detailed information is really able to shift consumer behaviours in favour of a new "unfamiliar" good instead of a similar good already in the market and commonly used among consumers. However, this is critical in understanding whether a new product that is still "unfamiliar" among consumers will be chosen by con-

sumers after they have received information about it and even after consumers have expressed a positive WTP for the "unfamiliar" good.

With this in mind, the goal of our survey was to explore whether providing farmers with information about digestate led them to have not only a positive WTP for digestate but also to understand whether the latter was higher or lower than the WTP for buying the cow manure. In fact, if the WTP for the digestate is lower than the WTP for the cow manure, buying digestate is unlikely to happen in the real market. In contrast, a higher WTP for the digestate in comparison with the WTP for the cow manure could indicate a real change in farmers' buying habits.

The comparison between the solid fraction of digestate and manure is possible because they are substitute goods that can be used in agriculture for the same purpose, namely as organic soil conditioners to improve soil structure and fertility.

To the best of our knowledge, this is the unique study carried out with farmers characterized by low exposure to the digestate which aimed to assess how information influences not only the WTP to buy the digestate but also whether the information leads to a real change in purchasing habits of farmers.

For this purpose, we used the multiple price list (MPL) method to assess farmers' willingness to pay for digestate which is "unfamiliar" among the farmers operating in areas where biogas plants are still not widespread in comparison with a well-known soil conditioner like the cow manure. MPL method is largely used for its ease of understanding among consumers and typically used in hypothetical surveys (Shew et al., 2017; Asioli et al., 2020). MPL method also allows to compare two substitute goods like we did in our survey in which we compared farmers' WTP between cow manure and digestate.

Our study focused on the Mediterranean area, where a new market for the digestate is required to have new income opportunities for plant owners (Gaviglio et al., 2014) and to reduce the typical dependence of the anaerobic digestion plants on public subsidies (Appel et al., 2016; Dahlin et al., 2017). In addition, the creation of a market for digestate appears to be an essential condition to promote in the Mediterranean area the production of biogas from agricultural biomass according to the sustainable principles of Biogasdoneright^{TM} without taking away agricultural land for food and feed production.

In our survey we evaluated farmers' WTP for the solid and palable fraction of the digestate in the Mediterranean area, where the number of plants is still low but is expected to increase in the coming years. Our research focused on the solid fraction of the digestate because it has an economic value and can be transported easily to farms not close to the production plants.

The results of our investigation expand the current literature on the factors that play a role in the digestate purchasing process with potential implications for expanding the sustainable biogas supply chain according to Biogasdoneright^{TM} principles.

2. MATERIALS AND METHODS

A hypothetical experiment was designed to assess the effects of information on farmers' WTP for solid fraction of digestate compared with cow manure.

At the end of 2020, a specific questionnaire was administrated by face-to-face interviews to a sample of 279 farmers (owners or managers). The survey was conducted in Sicily (Italy) in two different provinces (Enna and Syracuse) where there are no anaerobic digestion plants and farmers have no direct experience for the use of the digestate as soil conditioner. Farmers were recruited with the help of local agricultural unions and local cooperatives. Moreover, farmers were preliminary asked about their willingness to participate in the survey, and they were also asked some screening questions. More specifically farmers were asked if they were the owners or managers of the farm, if they were responsible for acquiring farm materials and if they already used soil conditioners on the farm or if they would be interested in doing. If all the answers were affirmative, those farmers were invited to take part in the survey.

Previous studies have explored whether information influenced farmers' WTP for digestate (Dahlin et al., 2015; Pappalardo et al., 2018; 2019) or farmers' willingness to entry digestate market (Selvaggi et al., 2021), but never have elicited willingness to pay of farmers put in front of the choice between digestate and cow manure. In our survey, we tested farmers' choices between a traditional soil conditioner and an innovative one, and we determined some variables correlated to the choices.

The experimental design was structured by randomly pooling participants in two groups: "control group" in which participants did not collect information on digestate and "treatment group" in which participants were provided with detailed information on digestate. The number of participants in the two group were different: 144 observations for the "treatment group" and 135 for the "control group".

The treatment was the provision of specific information on digestate and its attitude as organic soil conditioner (i.e., its physical and chemical properties, its

production chain and other). The information sheet provided specific information about the production process of anaerobic digestion plants from which digestate is obtained. In addition, a focus was made on the solid fraction of digestate (the subject of our research), specifying its chemical and physical properties as an organic soil conditioner, detailing its content in organic matter, moisture, nitrogen, phosphorus and potassium. Then, some information was provided regarding the systems and machines for its distribution. Finally, it was pointed out that, depending on the process from which digestate is derived, it can be used in organic farming.

The aim of the treatment was to reduce the lack of information that, according to the literature could create considerable uncertainty on the real value of the digestate (Pappalardo et al., 2018).

To elicit farmers' willingness to pay, the widely used multiple price list (MPL) format was applied. MPL is a popular method for elicitation of valuations in hypothetical experimental conditions (Andersen et al., 2007). MPL is an incentive-compatible valuation method in which participants are presented a column of ordered prices, and asked to respond with either "yes" or "no" for each price (Alfnes and Rickertsen, 2010; Andersen et al., 2006). Drichoutis and Lusk (2017) defined the principal advantage of the MPL the ease of use: the method is easy to use, and it is easy for participants to understand. Asioli et al. (2020), also found that MPL method is easier to understand for people and easy to decide on the responses than other method such as Becker–DeGroot–Marschak (BDM) method. However, Andersen et al. (2006) discussed the potential for choices in MPLs to be influenced by the ranges of values considered and Harrison et al. (2005) pointed out that inferences from MPLs can be influenced by order effects. Also, Andersen et al. (2007) put in evidence some disadvantages of MPL format linked to the possibility to elicit only interval responses and thus could be susceptible to framing effects.

The MPL approach allows to compare the answer of different subject between an array of ordered prices put in a table, one per row. We proposed a no traditional MPL, but we adapted the method to our necessity to compare two products. Respondents made a series of consecutive choices between two products. Researchers ask the participants to indicate "solid fraction of digestate" or "traditional cow manure" for each row with different prices for the two goods (Table 1).

Five different price combinations were proposed to each participant to elicit his/her WTP. So, every participant stated 5 preferences: one for every digestate-cow manure pair. The price for the cow manure was constant and equal to 10 euros per ton for every row in the list.

Table 1. Multiple price list used in the survey.

Digestate – Solid Fraction	Traditional Cow Manure
☐ 7.0 € / t	☐ 10.0 € / t
☐ 9.0 € / t	☐ 10.0 € / t
☐ 10.0 € / t	☐ 10.0 € / t
☐ 11.0 € / t	☐ 10.0 € / t
☐ 13.0 € / t	☐ 10.0 € / t

Instead, the five prices for the digestate were different and increasing from 7 to 13 euros per ton, because there is not a market for it. Prices for digestate were fixed considering both ± 10% and ± 30% discounts and surcharges on the market price of traditional cow manure (10 €/t). The choice between traditional cow manure and digestate was necessary for everybody, for every row in the table.

Moreover, to evaluate the possible correlation between WTP and basic socio-demographic characteristics, and to define the profile of the farmer interested in digestate, some information were collected on gender, age, educational level, average income and typical agricultural production systems.

To study more in deep which factors influence farmers' WTP for digestate, an Ordered Logit Model was performed. Considering highest WTP values for digestate for each participant, an Ordered Logit regression was executed. The dependent variable of the model was an observed ordinal response variable (McCullagh, 1980) classified into six different rising levels. The coefficients of the linear combination cannot be consistently estimated using ordinary least squares. They are usually estimated using maximum likelihood. For this reason, Ordered Logit Models require sufficient sample size: how big is "big" is a topic of some debate, but they almost always require more cases than OLS regression (Bujang, et al., 2018).

The Ordered Logit Model is based on the cumulative probabilities of the response variable: in particular, the logit of each cumulative probability assumed to be a linear function of the covariates with regression coefficients constant across response categories (Grilli and Rampichini, 2003).

The model was built around the structural model for ordinal outcomes with a single continuous latent variable (Greene, 2012). The regression model is specified as:

$$OrWTP_i^* = X_i'\beta + \varepsilon_i \quad (1)$$

Where:

- $OrWTP^*$ is the latent variable continuous and ranging from -∞ to +∞ for the i-th subject;

- X_i' is the vector of the explanatory variables;
- β is a vector of coefficients;
- ε_i is the vector of error terms.

In the model, a set of coefficients ($\alpha_1 < \alpha_2 \ldots < \alpha_{j-1}$) with j-1 intercept terms as cut-points in the distribution of the latent variable *OrWTP** was also estimated. The cut-points represent the threshold values for moving from one category of the *OrWTP* variable to another one. Consequently, the observed ordered variable *OrWTP* is tied to the latent variable *OrWTP** as:

$$OrWTP_i = j \text{ if } \alpha_{j-1} < OrWTP_i^* \leq \alpha_j \quad (2)$$

We estimated an ordered logit model in which the dependent variable "*OrWTP*" is classified into six different rising levels: "Never" refers to those who have never chosen digestate from the proposed rows; "First Choice" refers to those who chose digestate only in the first row of the MPL (7 €/t); "Second Choice" refer to those who chose digestate both in the first and in the second row of the MPL (7 and 9 €/t); "Third Choice" refers to those who chose digestate up to the break-even price with manure (7, 9 and 10 €/t); "Fourth Choice" refers to those who chose digestate for all the first 4 rows in the MPL (7, 9, 10 and 11 €/t); "Fifth Choice" refers to those who have never chosen cow manure from the proposed rows and have expressed a willingness to pay all prices shown for digestate (7, 9, 10, 11 and 13 €/t).

The dependent variable *OrWTP* has been related to some independent sociodemographic variables of farmers and a dummy variable considered to test the effect of the information on the WTP. The list of explanatory variables is reported in Table 2.

Table 2. Explanatory variables employed in the Ordered Logit Regression.

Variable	Code	Type	Values
Gender	*Gen*	Dummy	0 = Male 1 = Female
Age	*Age*	Continuous	21-81
Educational level	*Edu*	Categorical	1 = Elementary school 2 = Middle school 3 = High School Diploma 4 = Bachelor's Degree
Income range (yearly)	*Income*	Categorical	1 = < 10,000 € 2 = 10,000 - 19,999 € 3 = 20,000 - 29,999 € 4= 30,000 - 39,999 € 5= ≥ 40,000 €
Category of farm specialisation	*Cat_Spec*	Categorical	1 = Extensive seed and livestock 2 = Extensive tree crops 3 = Intensive tree crops 4 = Horticultural systems
Treatment effect	*Treat*	Dummy	1 for who received the information before to ask him/her the willingness to pay 0 = otherwise

3. RESULTS

Table 3 shows the main socio-demographic characteristics of the sample under analysis. We present the results for the sub-samples (Control Group and Treatment Group) and we performed statistic tests to estimate significant differences.

To exclude significant difference between the two sub-samples, two different tests were performed: (a) Chi-squared tests for the variables gender, educational level, income range and category of farm specialisation; and (b) Student T test for the variable age. The results of these tests are showed in the Table 4.

In both sub-samples, female respondents are fewer than male ones, the prevalent range age is 18-39 (about 38%) and the most represented educational level is High School Diploma. The prevalent income range is 20,000–29,999 euros per year (with different percentage in the two sub-samples) but it prevails only by a few percentage points compared with the yearly range of 10,000–19,999 €. The prevalent type of farming is "Extensive seed and livestock": about 50% of interviewed has cereal and feed forage and livestock farm.

There was no statistically significant difference between the two sub-samples, according to the range of tests (Chi-Squared and T) performed.

For each of the two groups analyzed, the mean WTP values for digestate was determined. Table 5 shows the results of this elaboration.

The mean WTP value for digestate for the Treatment group (8.46 euros per ton) was higher than the mean WTP value for the Control group (6.96 euros per ton).

Although the positive effect of information, the medium WTP value for digestate of the Treatement group was lower than the price of cow manure (10 euros per ton).

Moreover, the effect of the treatment (information) on the mean WTP values was tested through a T-test. The result of this parametric test performed showed statistically significant difference between the mean WTP values of the two sub-samples (p-value < 0.001). For T-Test the null hypothesis is diff = 0 and Pr is ($|T| > |t|$).

Therefore, we can conclude that the effect of information is confirmed by the current research: more infor-

Table 3. Socio-demographic characteristics of the sample.

	Control Group (n. 135 participants)	Treatment Group (n. 144 participants)	Test performed
	%	%	
Gender			(a)
Male	83.0	76.4	
Female	17.0	23.6	
Age			(b)
18-39	38.5	38.9	
40-49	31.1	29.9	
50-65	23.0	20.1	
> 65	7.4	11.1	
Educational level			(a)
Elementary school	6.7	5.5	
Middle school	28.9	18.1	
High School Diploma	42.9	51.4	
Bachelor's Degree	21.5	25.0	
Income range (€/year)			(a)
< 10,000	16.3	13.9	
10,000 - 19,999	27.4	22.9	
20,000 - 29,999	28.2	24.3	
30,000 - 39,999	17.0	20.1	
> 40,000	11.1	18.8	
Category of farm specialization			(a)
Extensive seed and livestock	56.3	50.0	
Extensive tree crops	33.3	37.5	
Intensive tree crops	9.7	11.1	
Horticultural crops	0.7	1.4	

Table 4. Results of tests performed to exclude statistically significant difference between groups.

	Test performed			
	Chi-Squared	Pr	*T-Test*	*Pr* *
Gender	1.85	0.17		
Educational rate	5.07	0.17		
Income range	4.28	0.37		
Category of farm specialization	1.28	0.73		
Age			0.08	0.94

* For T-Test the null hypotesis is diff = 0 and Pr is (|T| > |t|).

Table 5. Mean WTP values for digestate, for both sub-samples, and T-Test result (*).

	Observations [n.]	WTP values [€/ton]	Standard Error	Standard Deviation
Control Group	135	6.96	0.35	4.02
Treatment Group	144	8.46	0.28	3.39
	Mean WTP differences	p-value		
T-Test	1.50	< 0.001 ***		

(*) In the determination of the mean WTP values for digestate, the answer of who never buy digestate (who checked only cow manure in the MPL) was considered as 0 (zero).

mation about digestate increases willingness to pay but the price offered by farmers is always lower than manure one.

Table 6 shows the frequencies of the six categories of the dependent variable (*OrWTP*) used to estimate the effects of the explanatory variables on WTP values for digestate, in the Ordered Logit model.

The most of respondents stated that they are willing to pay for digestate at most 10 euros per ton (25.81%). Of the remaining part of the sample, only about 16% of the participants stated they are willing to pay more for digestate than for manure: 12.19% were willing to pay 11 €/t for digestate and only 3.94% were willing to pay 13 €/t for it.

Table 6. Frequencies of the categories for the dependent variable (*OrWTP*) of the Ordered Logit model.

Categories	Frequencies	
	[n.]	[%]
Never	47	16.85
First Choice	57	20.43
Second Choice	58	20.79
Third Choice	72	25.81
Fourth Choice	34	12.19
Fifth Choice	11	3.94

About 20% of the total sample stated their willingness to pay for digestate only at lower prices than for manure.

Approximately 17% of participants in the experiment did not choose to buy digestate, since the first combination of prices offered (7 €/t for digestate and 10 €/t for manure). This percentage of subjects who have never expressed willingness to pay for digestate, is distributed differently between the two groups of the sample: in the Treatment group, after providing information on digestate, only 11% of participants have never chosen digestate. This value rises to 23% in the Control group.

This confirms the effect of information on the probability of entering the digestate market, already investigated in the studies mentioned above.

In Table 7, the estimated coefficients of the Ordered Logit Model are reported, considering as regressors the variables collected in the questionnaire (socio-demographic characteristics) and the variable referred to the treatment. The relative statistical significance is reported for every variable considered.

To improve the reading of the model result, the categorical variable related to the category of farm specialization (*Cat_Spec*) was represented using a set of 4 dichotomous variables (dummy, coded as 0 or 1). Specifically, to avoid the dummy trap, the number of dummy variables used in the model is 3 (one less than the number of categories). Moreover, the variables "Edu" and "Income" were made dummy to avoid loss of degrees of freedom (Migliore et al., 2022) and because we are not interested in studying the effect of each educational level or income range. In particular for "Edu" was considered 0 for not graduated farmers and 1 for graduate ones; for the variable "Income" the dummy was fixed as 0 for lower yearly income range (< 20 k€) and 1 otherwise.

The cut-points of the output indicate where the latent variable is cut to make the six groups that we observe in the experiment.

Table 7. Results of the Ordered Logit Model.

Indipendent variables	Coefficients	Standard error	p-value
Gen	- 0.034	0.274	0.900
Age	- 0.004	0.008	0.601
Edu	0.044	0.148	0.765
Income	0.638	0.096	<0.001***
Cat_Spec_1	1.500	0.892	0.093*
Cat_Spec_2	1.758	0.897	0.050**
Cat_Spec_3	0.597	0.939	0.525
Cat_Spec_4	omitted		
Treat	0.764	0.220	0.001***
cut1	1.773	1.075	
cut2	2.966	1.0823	
cut3	4.022	1.099	
cut4	5.643	1.123	
cut5	7.3001	1.158	

Number of observations: 279.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

The likelihood ratio chi-square of 72.40 with a p-value of < 0.001 tells us that this model as a whole is statistically significant, as compared to the null model with no predictors. The pseudo-R-squared of 0.2770 is also given.

Some coefficients for the independent variables are statistically significant. In particular, the coefficients for the variables "Treat", the categorical variable for the income range and two of the dichotomous variables created for the category of farm specialisation, have positive signs and are statistically significant. All the other coefficients are not.

Also, the results of the ordered logit regression performed confirms the positive effect of the information on the WTP. In fact, the positive coefficient of the variable "Treat" statistically significant indicates that "information" can be considered a driver to increase respondents' WTP.

Moreover, the higher the income level the greater the willingness to pay. The result obtained for the income range is common in all market analysis. If farmers have high income their WTP increase.

In ordered response model both the sign and magnitude of coefficients are not directly interpretable (Greene and Hensher, 2010). So, we define the interpretation of the ordered logistic regression in terms of marginal effects. Marginal effects show the change in probability when the independent variable increases by one unit. For continuous variables (such as "age" in this model) this represents the instantaneous change given that the 'unit'

Table 8. Marginal effects for the statistically significant variables.

Indipendent variables	OrWTP categories					
	Never	First Choice	Second Choice	Third Choice	Fourth Choice	Fifth Choice
Income (*)	0.072	0.069		0.086	0.523	0.016
	<0.001 ***	<0.001 ***		<0.001 ***	<0.001 ***	0.001 ***
Cat_Spec_1 (*)		-0.146		0.186	0.122	
		0.043 **		0.045 **	0.101 *	
Cat_Spec_2 (*)	-0.172	-0.170		0.180	0.171	
	0.032 **	0.018 **		0.001 ***	0.087 *	
Treat (*)	-0.088	-0.080	-0.015	0.101	0.063	0.019
	0.001 ***	0.001 ***	0.011 **	0.001 ***	0.002 ***	0.013 **

Values in italic are p-value. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.
(*) dy/dx is for discrete change of dummy variable from 0 to 1.

may be very small. For binary variables, the change is from 0 to 1, so one 'unit' as it is usually thought.

In Table 8, marginal effects (dy/dx) are shown. Only marginal effects for the statistically significant coefficients are reported and only variables with at least one statistically significant coefficient were reported.

Since the dependent variable in this ordered logit model consists of six categories, the table shows six sets of marginal effects that describe the impact of a change in the covariates on the predicted probabilities. Technically, if the predicted probabilities obtained from the regression are different across the categories of the dependent variable, the marginal effects can be used to estimate their increase or decrease.

The variable "Treat" was the only one found to be always statistically significant, for each category of the dependent variable. The negative sign for the first three categories (never, first choice and second choice) indicates a lower likelihood that "informed" participants will be willing to pay more than "not informed" ones. For example, the probability that "informed" will willing to spend 9 €/t for the digestate (second choice in the table) is about 1.5% lower than for the "not informed".

For the highest prices for the digestate, the marginal effects for the variable "Treat" assumes a positive sign, indicating a higher probability that treated group will pay more than control group. When the price for the digestate is equal to that for manure, the probability that "informed" will willing to spend 10 €/t for the digestate instead of for manure is about 10% higher than for the "not informed".

Looking at the categorical variable "Income", the sign is positive for all the categories. Therefore, we can assume that those with higher incomes are more likely to have a higher willingness to pay than those with lower incomes. For example, the probability that famers with high level of income are willing to pay 11 €/t for the digestate (fourth row in the MPL) is 52.3% more than farmers with a low-income level. The result obtained for the "never" category is ambiguous. In particular, the significance of the "income" variable and the positive sign of the marginal effects coefficient cannot be easily explained. One possible explanation could be related to the "price" variable: the lower MPL limit set in the research (7 €/t) may have played a disincentive role for product choice. In fact, lower prices than those normally found in the market may induce mistrust in the consumer who chooses not to buy the commodity at a low price.

As regards the category of specialization, marginal effects have different signs according to the different categories of the dependent variable. Owners of more specialized crops than "extensive seed and livestock" are less likely to be willing to pay 7 euros for digestate. On the other hand, the same subjects are more probable to pay 10 euros and 11 euros per tonne, 18.6% and 12.2%, respectively, than the owners of "extensive seed and livestock".

Finally, participants with different crops than "Extensive tree crops" are less likely to be willing to pay 7 €/t for digestate and not to choose digestate from the first line of the MPL. In both cases, the probability is lower than 17%. As with the previous variable, the same individuals are 18.0% and 17.1% more likely to pay 10 euros and 11 euros per ton, respectively than owners with different specialization categories.

4. DISCUSSION AND CONCLUDING REMARKS

Previous studies have shown the existence of a positive farmers' willingness to pay for digestate especially

when farmers are provided with information on it (Pappalardo et al., 2019; Selvaggi et al., 2021). Our survey confirms what already shown in the past literature since the farmers' WTP for buying an "unfamiliar" good like the digestate was higher when participants were provided with information on the good itself (e.g., Aanesen et al., 2015; Börger and Hattam, 2017). However, our survey went beyond the current literature as the farmers' willingness to pay for digestate was compared with the willingness to buy a similar product already on the market and well-known among farmers. Indeed, after providing the farmers with the information on digestate, only 11% of the participants in the treatment group never chose digestate over manure, compared to 23% of participants in the group without information. The positive and statistically significant variable 'Treat' confirms that the effect of the treatment on farmers' WTP was statistically significant probably because in this case the commitment costs are lowered (Corrigan et al., 2008; Zhao and Kling, 2001; 2004).

Our results appear interesting as the willingness to pay for a good does not necessarily imply that a market for that good will occur especially when the good is "unfamiliar" among consumers. In fact, the willingness to pay for a good, even if positive, may be lower or equal than for similar and substitute goods already on the market and "familiar" among consumers. When this occurs, despite the existence of a positive willingness to pay, a market for the unfamiliar good may not occur. In this regard, in our survey we showed that although the positive effect of information, farmers have predominantly stated that they are willing to pay to buy digestate but only when it is priced below or at the limit equal to the price of cow manure. This result goes beyond the scientific literature on digestate market (Herbes et al., 2020; Pappalardo et al, 2019; Selvaggi et al., 2021) since providing information to farmers can improve their WTP for digestate but the information alone seems to be not sufficient to create a digestate market. Our findings seem to suggest that conventional practices or habits among framers are stronger than innovation like introducing the digestate as new soil conditioner.

With reference to the categories of specialization, the owners of arable and extensive crops are less inclined to innovation because they do not face problems related, for example, to the distribution of soil improvers. Their technical solution is the use of the manure spreader and the use of manure for them represents an ordinary, traditional and established practice. On the other hand, farmers with specialized tree crops or horticulturists do not traditionally use manure for obvious technical reasons related to the impossibility of using manure spreaders on their fields (in the case of tree crops) or inside greenhouses (for horticulturists). In addition, especially horticulturists, face health problems related to the bacterial load of unripe manure, which could contaminate vegetables in the field, while the solid digestate proposed in the research would ensure safety from this microbiological point of view.

Implications of our survey can be relevant for the owners of digestion plants, who need to sell digestate to improve their cash flow. Although the digestate is a good substitute of other organic soil conditioners like the cow manure, farmers do not know it and their decisions are influenced by the low level of knowledge about digestate properties. Providing only information on the benefits of digestate could be insufficient or even ineffective. Therefore, it would be necessary to think about the ways in which the information should be provided to farmers in order to increase its effectiveness.

The research shows that farmers are interested in entering the digestate market, so incentive policies to get this product out there would be desirable.

As recommendations for policy makers and operators in the biogas supply chain, our findings suggest enhancing technical information both among farmers for the benefits of digestate to soil fertility and among biogas producers for the positive economic impact that digestate has for the anaerobic digestion companies that convert a waste into an economic resource. Then, as in the real market happens for any commodity, farmers may or may not purchase this good after being sufficiently informed about it. But thanks to the information they receive, they will be able to consider buying it as a substitute for traditional manure.

Despite the care taken by the researchers in providing only objective and general information about the chemical and physical characteristics of the product, without extolling its merits or flaws, it is to be expected that the results were affected by the type of information provided to farmers. Future research should explore different approaches of how to provide information to farmers and in particular the design of the information intervention, e.g. providing participants with quantitative information like official statistics (e.g. Kuziemko et al., 2015) or reporting anecdotal evidence, stories, and narratives providing participants with qualitative information which closely resembles case studies (e.g. La Ferrara et al., 2012) or tailoring information to individuals (e.g. Roth and Wohlfart, 2020). Moreover, it could be interesting to define the reasons for the differences between the WTP values for digestate and other similar soil conditioners like the cow manure. Finally, future research could deepen the degree of farmers' propensity

for introducing innovation within the farm such as the digestate.

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